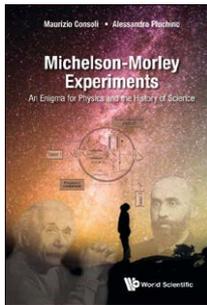


# RECENSIONI



MAURIZIO CONSOLI, ALESSANDRO PLUCHINO

## MICHELSON-MORLEY EXPERIMENTS AN ENIGMA FOR PHYSICS AND THE HISTORY OF SCIENCE

World Scientific, Singapore, 2018

hardcover: pp. 196, GBP 70.00  
ISBN: 978-981-3278-18-9

e-book: GBP 55.00  
ISBN: 978-981-3278-20-2

### Welcome back, Mr. Aether!

Modern classroom physics usually starts with two crucial steps: the explanation of the black-body radiation spectrum, as a compelling evidence of quantum physics, and Michelson-Morley (MM) experiments, which failed to prove the existence of aether, *i.e.*, of an absolute reference frame, thus paving the way to Einstein's relativity. Although general relativity and quantum physics still look for a convergence after one century of huge developments (and some misunderstanding) along parallel trails, subtle deviations in both experiments are prelude to a long-sought reunification. Among all theories of the physical world, quantum physics is by far the most precise ever achieved, and so is the black-body radiation spectrum: any tiny deviation from its distribution, as revealed in the Cosmic Microwave Background (CMB), is significant and of paramount importance in elucidating the matter distribution of the primordial universe. Similarly, MM experiments, though having sufficient precision to exclude aether in the naïve form it was conceived over the centuries, did not yield exactly null results. Small deviations unavoidably call for new tests, whenever the progress in interferometry and spectroscopy allow for, and the results are clearly paying the effort: the aether is back under its real clothes, those of quantum mechanics, seemingly the CMB itself!

This book has the great and uncommon virtue of combining the fascinating tale of a crucial step in the history of science with the related research sections, where the substantial contributions made by the authors themselves in this exciting field are reviewed. While the tutorial part of the book has a captivating style, suitable to entertain a general readership, the research chapters expose in a critical approach, based on the authors' thorough research work, the fundamental implications that Michelson-Morley's (MM) experiments in their more recent versions are having on present astroparticle physics and cosmology.

The introductory chapter gently brings the reader *in medias res*, telling about the MM apparently fatal blows to aether, and the way they have triggered the first Einstein's

formulation of special relativity, and later the revolutionary step of general relativity. The motivations of MM experiments had deep roots in the past, as nicely told in the history chapter. Greek atomists conceived matter as an aggregation of invisible atoms dancing in vacuum. On the other side Aristotle's *horror vacui* provided an ontological frame to natural philosophy for about two millennia, until atomism seemingly provided the correct picture of the physical world. Plato, having at hand the five "Platonic" solids, assigned the shape of four of them to the four basic constituents of nature – the tetrahedron to fire, the octahedron to air, the icosahedron to water and the cube to earth – leaving the fifth polyhedron, the dodecahedron, in search of the mysterious fifth element, the *quintessence*. The concept, solving Aristotle's obsession, pervaded medieval philosophy under various disguises, until it was welcomed in classical physics for providing the medium of force fields in Newton's gravitation and Maxwell's electromagnetism. In this role it regained the original name of *aether* (αἰθήρ), by which Plato's Timaeus termed the most translucent kind of air. Of course the ontological basis of aether and vacuum kept being matter of concern for Descartes and Kant, as well as for physicists dealing with ondulatory phenomena (Young-Fresnel hypotheses) and the apparently immaterial transmission of energy and momentum through space. Was the atomistic model of nature exhaustive? The quantum duality had apparently solved the issue, but in the meantime the term *quintessence* is peeping out in cosmology [1, 2], now confronted with a new problem: besides the four fundamental force fields (two of which unified), is there a fifth one associated with the accelerated expansion of the universe?

The book explains in great detail Michelson's 1881 and MM 1887 experiments reproducing the original figures and the consequences on the formulation of relativity principles: from the Lorentz transforms to first Einstein's formulation of special relativity in 1905. Quite impressive and instructive is the accurate report about the ideological (antisemitic) opposition to Einstein's theory by a group of German physicists, later severely compromised

with the Nazi regime. Since also Michelson was Jewish, one of the best Lenard's pupils, Rudolf Tomaschek, concluded in 1935 that "the aether was a conception the Jews would like to abolish", whereas Lenard himself announced that "the concepts which provide solid support for mental images of the aether have indeed been found" [3]. Despite this anthology of absurdities, the search and quantification of possible deviations from MM null result was seriously pursued by Morley and Miller, then again by Miller in 1925-26, Kennedy (1926), Illingworth (1927), Piccard and Stahel (1926-28), Joos (1930) and others who critically refined the methods, thus contributing increasing evidence of a residual drift.

The careful authors' analysis and re-analysis of the existing data rely on their wisdom in statistical physics, notably in non-additive thermodynamics. The latter is necessarily implied by the long-range nature of gravitational and electromagnetic forces, with fundamental consequences in quantum cosmology. The disputes over the formulations of non-extensive thermodynamics, still running despite the authoritative book on *Nonextensive Entropy* edited in 2012 by Murray Gell-Mann and Constantino Tsallis [4], look like a follow-up of those about the MM experiments. Interestingly the question whether temperature fluctuations of the CMB radiation are a case of nonextensivity was raised already by Tsallis *et al.* in 2006 [5]. Murray, who unfortunately passed away just a few weeks ago, would probably have enjoyed this link with the evergreen MM story. Actually the concluding chapter of this excellent book presents a discussion of the quantum-field theoretical basis for a possible association of the residual drift to the quantum vacuum structure, the Higgs field or the presence of the CMB. As a matter of fact quantum field theory has filled vacuum with a lot of stuff, not to mention dark matter and energy suggested by theoretical cosmology. Again aether presents itself disguised in various manners: welcome back Mr. Aether!

Giorgio Benedek  
Università di Milano-Bicocca

## Bibliografia

- [1] R. R. Caldwell, R. Dave and P. Steinhardt,  
*Phys. Rev. Lett.*, 80 (1998) 1582.
- [2] M. Cicoli, F. G. Pedro and G. Tasinato,  
*J. Cosmol. Astropart. Phys.*, 2012 (2012) 044.
- [3] A. D. Beyerchen, *Scientists under Hitler* (Yale  
University) 1977.
- [4] M. Gell-Mann and C. Tsallis (Editors),  
*Nonextensive Entropy: Interdisciplinary  
Applications* (Oxford University Press) 2004.
- [5] A. Bernui, C. Tsallis and T. Villela, *Phys. Lett.*  
*A*, 356 (2006) 426.